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Report on Experiments for the Control of the White Pine Weevil by Aerial Application of DDT

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Introduction

The white-pine weevil, Pissodes strobi (Peck), probably causes more damage to conifers in forest plantations, particularly to white pine and Norway spruce, and in open growing stands of white pine of natural reproduction throughout the northeastern part of the United States than all the other insect pests which attack these trees. Although this insect causes the death of but very few trees, one or more attacks may ruin one or more log lengths for first grade lumber. Continued attacks cause the so-called "wolf" or "cabbage" type of trees, some of which are not even worth cutting for use as box boards.

In connection with the cooperative studies carried on by the Division of Forest Insect Investigations of the Bureau of Entomology and Plant Quarantine and the New York Conservation Department to develop ways and means of preventing damage and for controlling insect pests in forest plantations, one phase is to develop a practical and economical method of controlling or preventing damage by the white-pine weevil.

The discovery of new insecticides and recent improvements in distributing apparatus, so that large acreages can be sprayed economically, prompted experiments in airplane spraying for the control of this insect.

Airplane applications of DDT in 1945 and 1946 with relatively low dosages and volumes of spray resulted in unsatisfactory control of the white pine weevil. In the spring of 1947 laboratory experiments were conducted and the results in-

dicated that although low dosages (1 to 2 lbs. per acre) of DDT were effective for two or three days in killing weevils, these dosages did not give satisfactory control after a week or ten days exposure to the weather.

Field Experiments for 1947

Because of the unsatisfactory results thus far obtained in the aerial application of DDT for the control of this weevil it was planned this year to use somewhat heavier dosages and volumes of spray per acre. This was to assure a better coverage and a greater residual effect on the twigs and branches of the trees which are frequented by the adults. Two series of applications were planned, each containing similar dosages of solutions and emulsions. Thus, in the first series there were four plots to be treated with solutions, and another set of four plots with emulsions. The second series was to be a replicate of the first. The dosages decided upon were as follows:

4 1/2 lbs. DDT in 4 1/2 gallons per acre
3 lbs. DDT in 3 gallons per acre
1 1/2 lbs. DDT in 3 gallons per acre
1 1/2 lbs. DDT in 1 1/2 gallons per acre

Formulas for Solutions and Emulsions

Solution: 1 lb. DDT, 1 qt. xylene, qs. kerosene to make 1 gallon

Emulsion: 1 lb. DDT, 1 qt. xylene, 2 oz. Triton X-100, qs. water to make 1 gallon.

Selection of Plots and Degree of Infestation

A total of 1,378 acres of plantations was selected for treatment on State reforestation areas in Jefferson and Lewis Counties, New York, the aim being to treat all white pines within a given area. As other species of conifers were

also planted on these reforestation areas, all the white pines were not in one block and some were growing in mixtures of other species. The areas selected for spraying were divided into 18 plots, the smallest covering 16 acres and the largest 125 acres, with the majority ranging between 85 and 105 acres each. All plots were laid out by chain and compass. Barriers such as roads, fence rows, wood edges, so-called game strips and fire lines were used as boundaries of plots wherever possible in order to minimize the danger of spray drift from one plot to another, and in most cases the location of these governed the size of the plots. The corners of each plot were marked by wind socks so that they could be easily located by the airplane pilots.

The conifers in the plots had been planted, for the most part, between 1936 and 1940. Line surveys were made through the plots in August to obtain data on the percentage of trees weeviled in 1947. Of 16,500 white pines examined 4,682 of them or 28.4 percent had the terminals killed by weevils this year. The degree of attack ranged from a low of 14 percent in plot 1 to a high of 43 percent in plot 14; however, in 11 of the 18 plots the range was between 21 and 29 percent of the white pines infested in 1947.

Because of the heavy dosages of DDT to be used on some of the plots it was deemed advisable to have representatives of the New York Conservation Department Division of Fish and Game make a study of the effect on wild life in these plots. In order to facilitate their work and to make their studies more conclusive it was planned to use plots that were contiguous for the heavy dosages.

Time of Spraying

It was agreed that the spraying operations should be started as soon as the majority of the 1947 breed of adults had emerged. The emergence period extends over several weeks and it was found that by the time the last larvae had pupated the majority of adults had already emerged. This period undoubtedly varies from year to year, but based on field observations in 1947 it was determined the majority of adults had emerged by September 1st.

Equipment and Materials

New York State-owned Stearman biplane #NR604 was used for making the applications. A New York State-owned spray truck and one loaned by the Division of Gypsy and Brown-tail Moths Control, U. S. Department of Agriculture, were used to mix the insecticide. A liquid meter mounted on each of the spray trucks measured the gallonage of the insecticide as it was pumped from the mixing tanks to the plane. A 1 1/2 ton stake-body truck owned by New York State was used for hauling some of the supplies.

The DDT, Xylene, and Triton K-100 was supplied by the Division of Forest Insect Investigations, U. S. Department of Agriculture and the kerosene for the spray solutions and the gasoline and oil for the airplane by the Division of Forest Pest Control, New York Conservation Department. The equipment was stored at and the loading and flying was done from the Bradley Airport, Watertown, New York.

Application

The insecticide was dispensed through twin nozzles mounted under each of the lower wing tips of the plane and through an additional pair of nozzles mounted close to the tail of the aircraft. Pressure during spraying was maintained at 130 pounds by a wind driven gear pump, and controlled at a constant pressure by a pressure relief valve. The nozzles were equipped with 0.187 inch nozzle discs. The insecticide flow rate was 24.3 gallons per minute, which produced an application at the rate of 1 1/2 gallons per acre. Those plots having dosages of 3 gallons per acre were flown twice, and those having 4 1/2 gallons per acre three times. An additional 10 percent of the total volume of spray per plot was added to compensate for spillage and drift

from the areas. The amount of gasoline in the fuel tank of the plane, the flying conditions, and the amount of insecticide required to finish a plot, were factors which governed the gallonage of spray materials carried on each flight. The average for the entire project was 55 gallons per load.

Three men with white flags guided the pilot on each 90-foot swath. One man was stationed approximately in the middle and one on each end of the swath, and each moved over 90 feet for the next swath as soon as the plane had flown over him. When weather conditions were favorable the spraying was begun at sunrise and continued until the wind or convextion currents of air made it necessary to discontinue operations. The spraying operations were again resumed each evening between 5:00 and 6:00 P.M., weather permitting, and continued until dark.

The first flight for spraying was made at 6 AM on September 4th and the flight for the last load was completed at 11.07 AM on September 23rd. Unfortunately, freezing weather during the night of the 23rd made it necessary to cancel the spraying operations before the project was completed and only 11 of the 18 plots were sprayed. Although the weather was fair throughout most of the period, the winds much of the time were too brisk to permit a proper distribution of the spray. This delayed operations and added tremendously to the cost. Altogether 66 loads of spray were put out from September 4th to 23rd inclusive, 23 of which were applied on two days, September 4th and 17th.

Data on the acreage of the plots sprayed, the dates and time of spraying, the dosage and gallonage of insecticide used and the number of flights are summarized as follows:

Plot No.	Acreage	Dates of Spraying	Time of day of Applications	Dosage per acre	Total gallonage	No. of flights
4	88	Sept. 4	6-11 AM	4 1/2 lbs in 4 1/2 gal.sol.	431.5	8
3	125	4&5	(6.12-7.30 PM (6.15-9.02 AM	3 " " 3 " "	415.5	8
16	60	5	9.15-11.07 AM	1 1/2 " " 3 " "	193.0	3
13	105	5	5.32-7.10 PM	1 1/2 " " 1 1/2 " "	171.0	3
10	90	6&7	(5.20-7.30 PM (6.30-9.14 AM	4 1/2 " " 4 1/2 " emul.	452.0	8
9	90	7,9, 10,13	(6.48-7.30 PM (8.55 AM (6.55 PM (9.10-10.13 AM	3 " " 3 "	344.0	7
15	85	13&14	(6.51 PM (7.53 AM&6.59 PM	1 1/2 " " 3 "	276.0	5
12	102	14&16	(7.11PM (6.27-7.31 AM	1 1/2 " " 1 1/2 "	180.0	3
6	88	16&17	(8.02 AM (6.25 AM	4 1/2 " " 4 1/2 " sol.	452.0	8
7	70	" 17	10.03 AM-1.20PM	3 " " 3 "	240.0	4
8	90	"17,20, 22,23	(5.45 PM (6.37 PM (7.24 AM (9.17 AM	4 1/2 " " 4 1/2 " emul.	475.0	9
Totals						
11 (plots)	993 acres	Sept.4-23			3630.0	66

Methods of Sampling and Results

It has already been mentioned that line surveys were made in each plot in August to obtain data on the percentage of trees weeviled in 1947. From 400 to 1,500 white pines were examined in each plot, the number depending upon the size of the plot. This information will be of value in checking the amount of damage by the weevil in the plots in 1948.

A plan was devised for sampling the white pines in the plots to obtain data on the population of weevils in each. Modifications of the plan were necessary after tests in the field showed the method was too tims consuming. A "beater cloth" which consists of a piece of white sheeting, approximately one yard square, suspended between two light wooden poles for handles was held by one man beneath the branches of the upper whorls while the second man tapped or jarred the branches and terminal with a short club. The numbers of white pine weevils dropping onto the cloth were recorded for each tree sampled.

The following table gives the results of the sampling prior to the spray treatment. The plots are listed in the order in which they were sampled.

Plot No.	Date	Trees weeviled in 1947 No.sampled	No.of weevils	Trees not weeviled in'47 No.Sampled	No.of weevils	Total Trees Sampled	Total No. Weevils
3	Sept. 3	75	137	120	5	195	142
4	" 3	62	151	123	6	185	157
16	" 4	56	103	84	5	140	108
13	" 5	68	166	97	11	165	177
10	" 5&6	85	198	145	22	230	220
9	" 6	100	234	140	11	240	245
15	" 6	34	81	41	4	75	85
6	" 6&8	92	312	153	19	245	331
12	" 8	111	319	149	40	260	359
7	" 9	57	109	53	7	110	116
8	" 9	143	423	167	35	310	458
5	" 11	167	322	113	20	280	342
17	" 12	42	96	13	2	55	98
18	" 12	63	138	17	1	80	139
11	" 12&13	64	190	16	3	80	193
14	" 13&15	100	250	25	7	125	257
16 (plots)	Sept. 3-15	1319	3229	1456	198	2775	3427

In 16 of the 18 plots 2775 white pines, ranging in height from about 3 to 9 feet, were sampled by crews of two men each . Of those sampled 1319 had the terminal killed by weevils in 1947, and 1456 trees had been free from attack this year. A total of 3229 weevils was jarred from the trees which had been damaged by the insect in 1947, whereas only 198 were obtained from those trees not weeviled this

year. The results of these examinations indicate that approximately 95 percent of the adults feed during the late summer on the trees from which they had emerged and that there is little migration of adults prior to cold weather. An average of 2.45 weevils per tree was obtained from the weeviled trees.

Originally it was planned to sample five trees at regular intervals through each plot, but due to briar patches, small swamps and areas where there was poor survival of pines this plan was abandoned. Representative samples were obtained by running zig zag lines through each plot, the number of samples depending somewhat upon the size and condition of the plot.

The first sampling of each plot was made a few days prior to the spray application, a second one about five days after the plot had been treated, and a third and final sampling about a week or ten days following the second. It is believed that the results obtained by the method of sampling gave fairly accurate information on the abundance of adults, the effect of the spray treatments, important data on the dosages and the residual effect of each formula.

Data obtained from sampling of trees in the spray plots, both prior to and following the treatments, together with data from the check areas have been summarized in the following table. The terminal growth of all trees included in this table had been killed by the 1947 brood of weevils.

Plot No.	Date Sprayed	Dosage per acre lbs. gal.	Pre-treatment Counts: Date	Pre-treatment Counts: No. of trees	Pre-treatment Counts: Average weevils per tree	Post-treatment Counts 1st examination: Date	1st examination: No. of trees	1st examination: Average weevils per tree	1st examination: Per cent reduction	2nd examination: Date	2nd examination: No. of trees	2nd examination: Average weevils per tree	2nd examination: Per cent reduction	Checks: Date	Checks: No. of trees	Checks: Average weevils per tree
	Sept.	Solutions	Sept.			Sept.				Sept.				Sept.		
4	4	4½-4½	3	62	2.44	9&10	131	0.33	86.5	17	200	0.01	99.6	16	50	2.82
3	4&5	3 -3	3	75	1.83	10	77	0.44	76.0	16-17	200	0.14	92.3	17	30	2.13
16	5	1½-3	4	56	1.84	10	50	1.08	41.3	17	150	0.57	69.0	17	25	2.00
13	5	1½-1½	5	68	2.44	15	50	1.62	33.6	18	100	0.66	72.9	18	25	1.72
		Emulsions														
10	6&7	4½-4½	5&6	85	2.33	15	100	0.27	88.4	20-25	200	0.01	99.6			
9	7-13	3 -3	6	100	2.34	15	50	0.66	71.8	23-25	200	0.035	98.5	23-25	75	1.83
15	13-14	1½-3	6	34	2.38	18	50	0.92	61.3	24	50	0.26	89.0			
12	14-16	1½-1½	8	111	2.87	18	50	1.06	63.0	24	50	0.58	79.8	24	25	1.92
		Solutions														
6	16-17	4½-4½	6&8	92	3.39	23	50	0;04	98.8	25	50	0.00	100.0			
7	17	3 -3	9	57	1.91	24	50	1.30	31.9	26	50	0.06	97.4	23-25	75	1.83
		Emulsions														
8	17-23	4½-4½	9	143	2.96	25	50	0.28	90.5	26	100	0.05	98.3	23-25	75	1.83

Based on the examinations made in the untreated or check areas between September 3 and 25 there was a reduction of 14 per cent apparently due to natural causes.

From the data on post-treatment examinations, presented in the foregoing table, it is very evident that the heavier dosages, both of solutions and emulsions, produced the best measures of control. On October first, following the first period of freezing weather, some additional examinations of check areas were made, and although a number of weevils was jarred from the white pine twigs, the numbers obtained indicated that the majority had migrated from the trees to enter hibernation.

These plots will be examined next summer, soon after the injury by the 1948 brood is noticeable on nearby areas.

Further tests should be made, both early in the spring and late in the summer. These are necessary before any concrete recommendations can be made on aerial applications of insecticides for the control of the white pine weevil.

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Personnel

New York Conservation Department, Division of Forest Pest Control

Mixing of insecticides and applications

Supervising mixing and operations - J. M. Muiry

Airplane pilots - Robert Mason and Earl McGuirk

Operating Equipment and mixing insecticides -

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Selection, surveying, and marking of plots; flagging and signalling during spraying operations; sampling to determine degree of infestation and results of spray treatments.

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